

D.K. Yeomans (JPL/Caltech), R.W. Farquhar (JHU/APL), J. Kawaguchi (ISAS), C.T. Russell (UCLA), G.H. Schwehm (ESTEC), J. Veverka (Cornell Univ.).

Spacecraft Exploration of Asteroids: Past, Present, and Future

The in situ investigation of asteroids began with the Galileo spacecraft flyby of Gaspra in October 1991. The images of Gaspra covered about 80% of its surface, there were no craters larger than 3 km and the cratering age is about 200 million years. The subsequent Galileo flyby of the S-type asteroid Ida in August 1993 provided images over 95% of the surface and revealed a 1.5 km satellite, Dactyl, whose orbital characteristics enabled Ida's mass and bulk density to be determined. At least three craters with diameters comparable with asteroid Mathilde's radius were evident during the NEAR-Shoemaker spacecraft flyby in June 1997. As a result of its low bulk density and more than 50% porosity, Mathilde is likely to have a rubble pile construction. NEAR spacecraft data gathered during the one year orbital phase about asteroid Eros allowed a detailed shape and gravity model as well as a complete mapping of the asteroid's surface. The NEAR spacecraft successfully landed upon EROS on February 12, 2001 and continued to send back surface elemental composition measurements for another 16 days before spacecraft operations were terminated. As part of a spacecraft test of technologies, the NASA Deep Space 1 spacecraft flew past asteroid 9969 Braille in July 1999 but little in the way of useful science information was obtained. The major science results from each of these missions will be discussed.

Asteroid Name	Spectral Type	Size (km)	Bulk Density (cm/cc)	No. images/	
				Best Resol. (m)	Visual Albedo
951 Gaspra	S	18x11x9	---	57/54	0.23 (.06)
243 Ida	S	60x25x19	2.6(.5)	96/25	0.21 (.03)
253 Mathilde	C	66x48x46	1.3(.3)	500/160	0.045 (.003)
433 Eros	S	31x13x13	2.67 (.03)	160,000/0.1	0.25(.05)

Future asteroid missions will also be discussed including the planned Rosetta flybys of asteroids 4979 Otawara in July 2006 and the P-type asteroid 140 Siwa in July 2008 en route to a rendezvous with comet 46P/Wirtanen in November 2011. There is also a possible flyby of asteroid 5535 Annefrank by the Stardust spacecraft in November 2002. Asteroid rendezvous plans include the December 2002 launch of the Japanese MUSES-C mission to land upon, and return samples from, the surface of near-Earth asteroid 1998 SF36. Recently selected as one of three possible NASA Discovery concepts, the Dawn mission would launch in July 2005 and orbit asteroids Ceres and Vesta for 9 months each beginning with Vesta in June 2008.